TESTIMONY BY

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BEFORE
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ON COMMUNICATIONS

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Introduction

Mr. Chairman, my name is Tim Regan. I am a Vice President of Corning Incorporated. I understand that today's hearing is about the deployment of broadband to rural America. Obviously, this is of great interest to me as a representative of Corning. We are the original inventors of optical fiber, and of course, are anxious to see the technology deployed to all Americans, especially those in rural America.

But, I think it is important to address the question of broadband deployment to rural America in the context of the deployment to the nation as a whole. My argument is very simple. Broadband is not being deployed to residential customers in America, regardless of whether they are located in urban, suburban, or rural America. Business customers are getting it, but residences are not.

I know that you might find this statement somewhat astounding because you hear a lot about the so-called broadband deployment. Cable modem service, ADSL service (i.e., asynchronous subscriber line), and various wireless data services all claim by some, most notably the FCC, to be broadband. Without getting into semantics, I will argue in my testimony that these capabilities are more properly described as higher-speed data service, not broadband service.

I will also describe in my testimony recent economic research that Corning has commissioned to determine why broadband capability is not being deployed to residential customers. In short, the study identifies both financial and regulatory barriers to deployment.

Regulation changes alone are insufficient to get the job done.

<u>What's Broadband</u>

The first issue, of course, is the question of what is broadband. The answer is not obvious.

Oddly enough, the term "broadband" really comes from an older age – the analog age. In the analog age, the information-carrying capacity of a network was defined by the width of the band of spectrum used to carry a signal. The wider the band, the greater the information-carrying capacity. Thus, the term "broadband" was used to characterize a system capable of carrying a considerable volume of information.

In the analog world, a standard television video signal that requires 6 megahertz per channel was considered to be broadband. Voice at 4 kilohertz was thought to be narrowband.

In the digital world, the notion of broadband really doesn't apply. The information carrying capacity of a digital network is described as a bit transfer rate. As you know, digital signals are represented by a series of on and off signals that are characterized by pulses of electrons or photons. Transmissions in the digital world appear more like Morse code.

If we use standard television video as a service to characterize broadband, as we have done in the analog world, a bit transfer rate of 4 million to 90 million bits per second would define broadband. An uncompressed standard television video signal requires 90 million bits of information per second to transmit. It can, however, be compressed to 4 million to 6 million bits per second using what is called MPEG-2.

Data has become a very important form of information in the digital world. Remember that computers were originally called data processing machines. In the computer data world, the connections between computers are quite robust. A standard has evolved known as Ethernet, developed by IBM over two decades ago. It provides for the transmission of 10 million bits per second between computers on a local area network. Today, the Ethernet standard has been upgraded to a 100 million bits per second.

Frankly, I think the term broadband is so imprecise, it is probably useless at this point.

I think the better way of engaging the public debate is to identify bit transfer rates Americans will need to gain access to audio, video, and data applications. Table 1 below, which was taken from an article written by a Microsoft official, describes the transmission speeds necessary to gain access to a variety of applications.

Table 1

Network Transmission Speed Requirements for Real Time Audio, Video, and Data Applications

NEXTRECORD

Applications

Downstream Speed

Upstream SpeedENDFIELD

ENDRECORD

ENDFIELD
ENDFIELD
ENDFIELD
ENDRECORD

AudioENDFIELD
ENDFIELD
ENDFIELD
ENDRECORD

CD Quality SoundENDFIELD
256 kbps ¬ENDFIELD

ENDFIELD
ENDRECORD

Broadcast QualityENDFIELD
48 kbps to 64 kbpsENDFIELD

ENDFIELD
ENDRECORD

Plain Old Telephone ServiceENDFIELD
64 kbpsENDFIELD
64 kbps
ENDFIELD
ENDRECORD

ENDFIELD
ENDFIELD
ENDFIELD
ENDRECORD

VideoENDFIELD
ENDFIELD
ENDFIELD
ENDRECORD

Broadcast HDTV (compressed)ENDFIELD
20 mbps **S** / channel ®ENDFIELD

ENDFIELD
ENDRECORD

Broadcast Standard TV (MPEG-2 compressed)ENDFIELD

~ 4-6 mbps / channelENDFIELD
ENDFIELD
ENDRECORD

VideoconferencingENDFIELD
64 kbps – 2 mbpsENDFIELD
64 kbps – 2 mbps
ENDFIELD
ENDRECORD

ENDFIELD
ENDFIELD
ENDFIELD
ENDRECORD

DataENDFIELD
ENDFIELD
ENDFIELD
ENDRECORD

File Transfer (Ethernet)ENDFIELD
10 mbpsENDFIELD
10 mbps
ENDFIELD
ENDRECORD

Web BrowsingENDFIELD
240 kbpsENDFIELD
240 kbps
ENDFIELD
ENDRECORD

I. Network GamesENDFIELD
80 kbpsENDFIELD
80 kbpsENDFIELD
ENDRECORD

Source: Timothy C. Kwok, Microsoft Corporation, "Residential Broadband Internet Services and Applications Requirements," IEEE Communication Magazine June 1997, Tables 3 and 4, p. 80-81.

Notes:
1 kbps is one thousand bits per second.
1 mbps is one million bits per second.
Each television or multi-media device must have a dedicated channel.

If you think that Americans will need access to information in all its forms – audio, video, and data – it is easy from Table 1 to see that a capability in excess of 20 million bits per second downstream and 10 million bits per second upstream, even using the most advanced compression technology, is necessary. Let me explain with some examples of the bit transfer speeds necessary to do audio, video, and data:

II. Plain old telephone service requires 64 thousand bits per second both upstream and downstream.
III. Standard television using MPEG-2 compression technology uses 4 million to 6 million bits per second per channel downstream. Since there are on average 2 1/2 television sets in every household in America, three channels at 4-6 million bits per second each is needed.
IV. HDTV using the most advanced compression technology requires 20 million bits per second downstream.
V. And, 10 million bits per second both upstream and downstream – the so-called 10 Base-T Ethernet standard – is required to give people the same data speeds at home that they get at work in order to facilitate telecommuting.

I realize that my bit transfer speed prescription sounds like a lot. But, I believe it is what will be needed.

Let me clarify one point though. My comments about broadband should not be construed as criticism of ADSL or cable modem service. These are wonderful technologies. They enable the delivery of data at substantially higher speeds over the existing infrastructure that has been deployed by ILECs and cable operators. These services provide a useful transition to full broadband.

The FCC has stated in its Section 706 proceeding that broadband is 200 thousand bits per second – or 1% of my prescription. I do not see how the FCC can defend such a low standard in light of the speeds described in Table 1 above as necessary to transmit the applications we know of today, never mind the limitless array of new ones that will be created once the infrastructure is deployed.

The FCC and others have defined broadband at such a low level because they fundamentally misunderstand the nature of the future network. It has been described by the FCC as a superhighway. And, consistent with this analogy, the connections to the home are simply narrow on and off ramps.

This is the wrong analogy. The network of tomorrow, which will be dominated by data not voice, is not a highway. It is a series of bridges. The bridges connect islands of intelligence - computers. After all, this is what the Internet is. It is a network of computers, and each computer has the capacity to store and process hundreds of millions of bits of information.

Today, these islands of intelligence are for the most part connected by very narrow bridges, a copper pair that can transmit only 56 thousand bits. Even with these very narrow bridges, we have been able to realize tremendous economic benefit from connecting these islands of intelligence. Fed Chairman Alan Greenspan best characterized the impact of this connectedness in October last year before the Business Council when he said:

"Your focus on technology – particularly the Internet and its implications – is most timely...The veritable avalanche of real-time data has facilitated a marked reduction in the hours of work required per unit of output and a broad expansion of newer products whose output has absorbed the work force no longer needed to sustain the previous level and composition of production. The result during the last five years has been a major acceleration in productivity and, as a consequence, a marked increase in the standards of living for the average American household (emphasis added)."[1]

Tremendous economic prosperity has been realized over bridges that connect the computers at 56 thousand bits per second. Can you imagine what will happen when we can connect these islands of intelligence by bridges that can carry over 10 million or 20 million bits per second?

The question before us is how to build these bridges as soon as possible. The problem for rural America is particularly acute because the cost of building these bridges is 2-3 times higher than it is for the rest of the country.

C **How Do We Build the Bridges?**

Obviously, to deploy this new technology will require considerable investment on the part of all telecommunications carriers. The problem is, the dynamics to finance this investment have not been unleashed.

In fact, we have witnessed some unusual behavior. Incumbent local exchange carriers (ILECs) continue to deploy copper wire rather than new technology like fiber optics to provide service to new residential customers (i.e., "new builds") and to rehabilitate deteriorated plant that is serving existing customers (i.e., "rehabs"). They are spending approximately $9 billion deploying copper to serve new builds and rehabs in the residential market.

This reality was evidenced in a recent article in The Wall Street Journal which stated:

"Global sales of communications wire, from fiber-optic and coaxial cable to old-fashioned copper, rose 6% to $14 billion last year...Here's the most surprising part: The bulk of the industry's sales continues to come from the same type of wire Alexander Graham Bell developed in 1879 to transmit voice signals – copper (emphasis added)." 2

The fiber optics industry is somewhat puzzled by this investment behavior because fiber optic systems solutions today are at relative cost parity with copper. The cost parity between fiber optic and copper solutions for residential customers is well established. Last August, Matthew Flanagan, President, Telecommunications Industry Association, submitted comments to the FCC attesting to this fact. As evidence, he submitted sworn affidavits from four different telecommunications engineering experts who all supported the cost parity claim.3

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[1] Remarks by Alan Greenspan, *Information, Productivity, and Capital Investment,* Before the Business Council, Boca Raton, Florida, October 28, 1999.

[2] Mark Tatge, "Wire Makers Thrive Despite Advent of Wireless Phone", *The Wall Street Journal,* February 16, 2000, p. B-4.

[2] Matthew J. Flanagan, *re: Implementation of the Local Competition Provisions in the Telecommunications Act of 1996,* CC Docket No. 96-98, Telecommunications Industry Association, letter to Federal Communications Commission, August 2, 1999, which states at p. 6-7 that "In his Declaration, Mr. Cannata from Marconi Communications, demonstrates that POTS can be provided over a fiber-to-the-curb ("FTTC") system at 98 percent to 103 percent of the cost of providing POTS over a copper system using a digital loop carrier ("DLC/copper"). He notes further that the FTTC system can be upgraded to provide high-speed data (i.e., 10/100 Base T) by incurring a 16 percent incremental cost compared to a 40 percent to 50 percent incremental cost to upgrade DLC/copper to provide Digital Subscriber Line (xDSL) service. Finally, he demonstrates how a further upgrade to provide VHS-quality broadcast video can be deployed for an incremental cost of 44 percent over FTTC for POTS, which again compares favorably to the 40 percent to 50 percent incremental cost associated with the xDSL solution.
Mr. Jacobs from Corning Incorporated shows in his Declaration similar results with respect to broadband solutions. His analysis shows that an Ethernet fiber-to-the-home system (EFTTH") using multimode fiber can be deployed at 7 percent less than ADSL over copper, and EFTTH is substantially more capable. The EFTTH system

Because we are somewhat puzzled by this investment behavior, we commissioned a study by three Ph.D. economists, Drs. Kevin Hassett and J. Gregory Sidak, who are associated with the American Enterprise Institute for Public Policy Research, and Dr. Hal Singer who is associated with Criterion Economics. The study concluded that the ILECs and the CLECs are acting very rationally in delaying their decision to invest in new technology to serve residential customers. They identified both financial and regulatory explanations for the delayed investment behavior. 'rom a financial perspective, this delayed investment behavior is explained by a rather new model for explaining investment behavior known as the Dixit-Pindyck model. This model shows that when faced with certain conditions, a prudent investor will maximize his return by delaying investment in next generation technology. These conditions include a sunk cost investment, a high degree of market or technology uncertainty, and the absence of robust competition. Under these three conditions, which are all prevalent in the residential telephone market, a carrier is better off delaying a decision to invest in new technology.4 Since ILECs are

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can deliver POTS, 10/100 Base T data, and VHS-quality broadcast video, which cannot be done on an ADSL system. Mr. Tuhy from Next Level Communications states in his Declaration that "fiber-based narrowband solutions for local access serving residential end-users can be deployed at cost parity with copper-based solutions as measured on an installed first cost basis for newly constructed or totally rehabilitated outside plant." He makes a similar statement with respect to broadband. He notes that Next Level Communication's FTTC system "can be deployed to provide integrated voice, data, and video for the same cost as a copper-based solution with an ADSL overlay for high-speed data." This assumes new builds or total rehabs as well as first installed cost comparison.

Finally, Mr. Sheffer from Corning Incorporated addresses the rural deployment issue in his Declaration. He cites a proprietary Bellcore (now Telcordia Technologies) study prepared for Corning showing that the cost of narrowband fiber-to-the-home ("FTTH") at $2,370 per home passed beats narrowband DLC/copper at $2,827 per home passed. In other words, narrowband FTTH is 16.2 percent less costly than DLC/copper in a rural setting. More surprisingly, broadband FTTH also beats narrowband DLC/copper by 7.5 percent (i.e., $2,616 per home passed for broadband versus $2,827 per home passed for narrowband). Again, this analysis was based on new builds and total rehabs and the cost comparisons were done on an installed first cost basis.

[4] Kevin A. Hassett, J. Gregory Sidak, and Hal J. Singer, *An Investment Tax Credit to Accelerate Deployment of NewGeneration Capability*, February 28, 2000, p. 7, which states: "A simple example can make the point more intuitive. The traditional view is that one should invest in any project that has a positive net present value of cash flows. Recent advances in economic theory have shown, however, that this rule is not always correct. On the contrary, it is often better to wait if at all possible until some uncertainty is resolved and cost reduction can be achieved. Consider, for example, a firm that traditionally offers telecommunications services through copper wire. The firm must decide whether to install a new advanced broadband line that costs, say, $100 today but has an uncertain return tomorrow. Suppose that, if the demand for high-bandwidth services is high, the firm stands to make $400 profit. If, on the other hand, there is a bad outcome and the demand for the new services is low, then the new "pipe" will be underutilized, and the firm will gain nothing from owning it. If the probability of either outcome is 0.5, then the expected net present value of laying the new broadband line is, ignoring discounting, calculated as follows: (0.5 x $400) + (0.5 x $0) - $100 = $100. We can summarize this simple decision problem in the following table.

Scenario 1: The expected profit if firm installs a NG*i* fiber-optic cable that costs $100 and has an uncertain return tomorrow.

Today **Tomorrow**

Net

Good

Bad **Expected**

Invest
Invest
Outcome

Outcome
Return

-$100
$ 0 + (0.5 x $400) + (0.5 x $0) =
$100

Because the project has a positive expected cash flow, one might think it optimal to install the cable today. But it is not. If the firm delays making the investment, it can reduce the risk by observing the experience of others and
capturing the gains associated with deploying reducing-cost technology later. The value of waiting is that the firm can decide not to make the investment if the bad state occurs. We can summarize this subtler decision problem in the following table: (continued next page)

Scenario 2: Expected profit if firm waits and decides tomorrow.

Today **Tomorrow**

Net

Good
Bad
Expected
Invest
Invest
Outcome

Outcome

Return

$ 0
$ 0 + 0.5 x ($400-$100) + (0.5 x $0)
= $150

By waiting, the firm would increase its expected return by $50. If the firm invests today, it gives up an required to provide telephone service, they invest in copper solutions which are suited for just plain old telephone service.

The study goes on to conclude that the incentive to delay for ILECs is intensified by the so-called unbundling rules which require incumbents to allow their competitors to use parts of the incumbents' network at a regulated rate. This rate does not provide a sufficient return on investment to justify investment is new technology.

The parts of an ILEC's network that must be unbundled and resold to competitors are known as unbundled network elements, or "UNEs." The FCC has defined the price for the sale of these UNEs as TELRIC, or total element long run incremental cost. TELRIC attempts to value the various network elements based upon their forward-looking costs. The FCC believes that TELRIC replicates how competitive markets actually operate by approximating what it would actually cost an efficient, competitive firm to produce UNEs.

The study concludes that TELRIC pricing creates a disincentive to invest in new technology. It states:

"Most observers believe that mandatory unbundling [at TELRIC] limits the upside potential of any new investment project and that the expected return to investment in some projects may fall below the firm's cost of capital. …This disincentive to invest has been emphasized in the public debate over telecommunications policy by both incumbent local exchange carriers (ILECs) with respect to the local telephony networks, and by AT&T with respect to proposals that unaffiliated Internet service providers be given the legal right of mandatory access to AT&T's cable-television networks."5

In other words, the rate of return provided for TELRIC pricing is inadequate to give carriers an incentive to invest in new technology.

Other experts, including Kathleen Wallman, former Chief of the FCC's Common Carrier Bureau and Deputy White House Counsel as well as Supreme Court Justice Breyer, have observed this disincentive. Ms. Wallman stated in a speech to state regulators:

"Do we really mean to say that any carrier that is thinking of building a new broadband network should count on being able to recover, from day one of the operation, only the forward looking cost of their brand new network? I don't think so. No rational, efficient firm would take that deal. :ea firm ide Twates: Court Justice bleiny tcobserved have No sta

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option to invest tomorrow that is worth $50. The firm is better off waiting because it can avoid the loss of $100 by not purchasing the new cable in the bad state. Note that the two examples would have the same expected return if the firm were allowed to resell the advanced broadband line at the original purchase price if there is bad news. But that salvage scenario is patently unrealistic for two reasons. First, many pieces of equipment are customized so that,
once installed, they would have little or no value to anyone else. Second, if the demand for high-bandwidth services
is indeed low, then the advanced broadband line would have little value to anyone else. For these reasons, the investment in the equipment is "irreversible" or sunk in the sense that it has virtually no value in an alternative use.

[5] Id., p. 3-4

[6] Remarks of Kathleen Wallman at the annual convention of the National Association of Regulatory Utility Commissioners, Boston, Mass., Nov. 11, 1997.

[7] AT&T Corp. v. Iowa Util. Bd., 119 S. Ct. 721, 753 (1999) (Breyer, J. concurring in part and dissenting in part) (citing 1.H. Demstez, *Ownership, Control, and the Firm: The Organization of Economic Activity*, 207 (1988)).

[8] Stephanie H. Mehta, "Local-Phone shares Fall Amid concern Over Firms' Need to Invest, Rising Rate", *The Wall Street Journal*, Jan. 13, 2000, at B4.